

FINAL REPORT

# Independent Peer Review of the California High-Speed Rail Ridership and Revenue Forecasting Process

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Findings and Recommendations from the May-August 2012 Review Period

October 31, 2012

The Peer Review Panel held its sixth formal meeting on August 21-22, 2012 at the Parsons Brinckerhoff offices in San Francisco. The Panel also conducted discussions via electronic mail, teleconference, and videoconferencing both before and after this meeting. This report covers their activities and deliberations from May through August 2012. The panelists include:

- Frank S. Koppelman, PhD, Professor Emeritus of Civil Engineering, Northwestern University (chair)
- Kay W. Axhausen, Dr.Ing., Professor, Institute for Transport Planning and Systems, ETH Zurich (Swiss Federal Institute of Technology Zurich)
- Eric Miller, PhD, Professor, Department of Civil Engineering and Director, Cities Centre, University of Toronto
- David Ory, PhD, Principal Planner/Analyst, Metropolitan Transportation Commission
- Kenneth A. Small, PhD, Professor Emeritus, Department of Economics, University of California-Irvine

All panelists were present for the August meeting except for Dr. Axhausen, who attended via video-conferencing. Rick Donnelly, PhD, of Parsons Brinckerhoff (PB) served as facilitator and recorder for the Panel. In this capacity he serves at the convenience of the chair rather than as a representative of the project management team. The Panel invited several others to attend portions of the first afternoon and second morning sessions. They included David Kurth and Kimon Proussaloglou from Cambridge Systematics (CS) and Bill Davidson and Thierry Prate from PB. Mike Rossi, a member of the California High Speed Rail Board, joined the Panel at the end of the first day. All other deliberations of the Panel were closed to non-members.

## **1 Business Planning Context**

The panel made plans to contact Jeff Morales, Executive Director of the Authority, and others, as needed, to discuss direction of the Peer Review Panel over the next phases of the high-speed rail project and make changes in our focus as needed.

## **2 Model Evolution**

The travel models used by the Authority and their consultants have been the primary focus of the Panel to date. Since completing their first review of the initial modeling system used through the end of 2011 Panel has been asked to become more involved in applications of the model, as well as in advising the Authority on how the model system should evolve to meet current and anticipated needs. As a result, we have refined our recommendations about how the various improvements to the model can be sequenced into the Authority's activities, including the 2014 Business Plan. In particular, we have considered more precisely the priorities for developing components of the major revision to the model, which we have called "Version 2.0," and now recommend certain of these to be completed for the 2014 Business Plan. Future versions of the model system will be developed in response to evolving Authority requirements beyond those that can be addressed by the Version 2.0 model system.. More detail on these recommendations is described in the following sections.

## **2.1 Progress since Version 1.0**

The Panel has conducted a thorough review of the Version 1.0 modeling system over the past 18 months. CS has completed several updates to it over the same period, many in response to comments and recommendations from the Panel. A number of short-term issues were resolved early on, as documented in the Panel's second report (August 2011). Among them were the findings that distance effects were adequately represented in the model for the levels of analyses being carried out, a better representation of observed heterogeneity could be deferred, and the model was appropriately sensitive across a range of reasonable levels of service (LOS) inputs. The Panel also concluded that neither the constraint on HSR vehicle headways nor the constants in the model, while larger and more influential than desired, unduly affected model results. These and other findings improved the Panel's confidence in the model and forecasts developed using it.

An interim model system, Version 1.1, was completed in early 2012. The Panel reported on its review of the changes in its third report (February 2012). These changes included modifications to forecasting inputs, including LOS and other operating characteristics; revised base year socioeconomic inputs; and the incorporation of results of a limited Internet survey of long distance travel patterns collected by Harris Interactive. A post-processing method was developed by CS to factor existing forecasts to account for changes in trip-making and travel patterns reflected in these more recent data. Finally, the Panel examined key inputs used in the preparation of the 2012 Business Plan forecasts, including automobile operating cost assumptions, bus transfer and access times, and station-specific flow patterns. These issues were discussed in the Panel's fourth report (May 2012).

## **2.2 Version 1.5**

The Authority plans to release a revised business plan in 2014. To allow adequate time for effective public review and comment, the draft plan must be completed by November 2013. Working backwards from that deadline, Thierry Prate of the PB Program Management Group (PMG) indicated that the forecasting work in support of it must begin no later than June 2013. This will preclude the use of a fully developed new modeling system, like that we define, further in this report, as Model Version 2.0, for that purpose. In particular, the re-estimation, re-calibration and re-validation of models using the on-going California Household Travel Survey (CHTS) and the new revealed preference-stated preference (RP-SP) survey recommended by the Panel were never intended to be completed by June 2013. Data from both surveys will be required for the development of the Version 2.0 model.

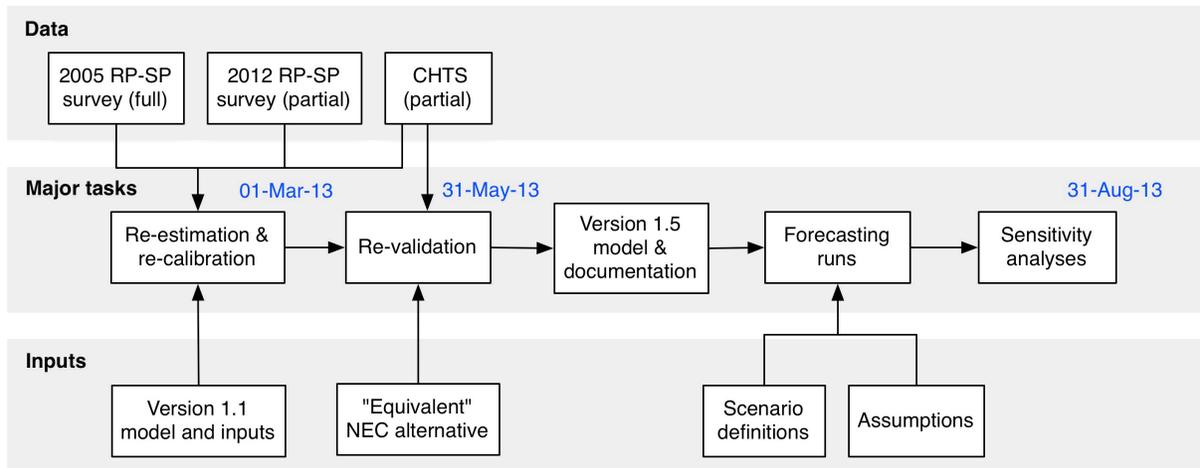
The Panel discussed a number of options before recommending a Version 1.5 model that is expected to meet the needs of the Authority for BP 2014, while at the same time addressing many of the remaining concerns of the Panel that could not be addressed in the Version 1.1 model system. The model system 1.1 (both structure and implementation) will remain unchanged in Model System 1.5. However, some of the individual model components will be substantially updated using revised specifications and estimations. Moreover, additional data (portions of the 2012 RP-SP survey and CHTS) will be used in the estimation, calibration, and validation processes. Furthermore, some revealed preference (RP) data from the 2005 surveys, which was not previously used in estimation, will be pooled with the stated preference (SP) data from the same surveys, to improve estimation precision and to better establish commonalities between

survey respondents' answers to the two parts of the survey. CS has already compiled the 2005 RP data.

A suggested plan for developing the Version 1.5 model is shown in Figure 1. It includes the following major tasks:

- The main haul and access/egress mode choice components of the Version 1.1 model will be re-estimated using the pooled RP-SP data from 2005 and as much of the new RP-SP survey data as can be collected and processed by the end of February 2013 (the presumed latest date by which CS must begin this task). The trip frequency and destination choice components will be re-estimated using as much of the preliminary CHTS data as are available at that point. The resulting models are expected to largely follow the original specification, although alternative formulations that improve model fit, clarify the interpretation of relationships, are consistent with theory or address issues previously identified by the Panel should be considered. The re-estimated models will be calibrated using previously developed targets and all preliminary data from the CHTS available at the outset of this task. The calibration will focus on system-level measures
- Two validation tests are highly recommended by the Panel. The first is a backcast to 2000 and comparison of the model predictions to the observed 2000 travel patterns. It is acknowledged by the Panel that some year 2000 comparison data may be difficult to reconstruct at this point, but best efforts should be made to do so. The second is a test of the Version 1.5 model against an "equivalent" Northeast Corridor alternative, like that conducted late last year as a reasonability check for the Version 1.0.
- Documentation for the Version 1.5 model should be posted on the Authority's website.
- Forecasts should rely on transparent assumptions about key exogenous inputs (e.g., fuel price trends, socioeconomic growth rates, changes in household size and structure) and scenario and LOS definitions provided by the Authority or its program management consultant. A concise summary of these assumptions should be made available to the public on the Authority's website, and a more detailed review of them should be completed by the Panel before they are finalized.
- A range of possible futures can be constructed by conducting sensitivity analyses of the effects of changes in key assumptions and inputs on the scenarios defined in the previous step. This information should be used by the Authority to inform the assessment of risk and uncertainty associated with the forecasts.

The Panel understands that all of these activities must be completed by early June 2013 for the model to be useful for the 2014 Business Plan. The Version 1.5 model that emerges from this effort should address all of the short-term issues identified by the Panel in their first and second reports, and some of the long-term issues as well. It will provide a sound basis for the 2014 Business Plan.



Deadlines shown in blue mark the end of the associated task

Figure 1: Version 1.5 approach and timeline

### 2.3 Model Version 2.0

Adaptations of the current model are suitable for relatively high-level analyses, such as feasibility analyses, corridor definition, environmental analyses, and development of system-wide business plans. However, the Panel remains convinced that a second-generation (Version 2) model will be required to meet the Authority’s long-term goals of completing detailed planning studies. The following analyses may require model refinements that should be part of Version 2.0 model system:

- The impact of pricing strategies, such as variable time-of-day pricing and multi-day passes, on revenue generation
- The impact of station design decisions, including parking lot sizing and pricing, platform length, and station capacity/seating on station choice
- The impact of local transit feeder systems on station access and egress choices
- The impact of major changes in the roadway network on highway congestion and subsequent mode choice decisions
- The impact of special markets, such as convention centers, hotel clusters, and sporting event venues on HSR demand

The Version 2.0 models will make full use of the CHTS and 2012 RP-SP surveys. These data may be augmented with the 2005 travel survey if testing reveals value in doing so. If the Authority moves forward with the development of a Version 2.0 model, the proposed specification and estimation results of the model components should be critically reviewed, along with the process used to adjust the estimated models during subsequent calibration and validation. It is anticipated that re-specification will be explored for all model components and their interactions in the Version 2.0 model.

It is important to note that the imperative for developing the Version 2 model – a technical requirement driven by anticipated future decision requirements – is not an indictment of Version

1.1 model. The latter was designed to assess the feasibility of the system, and has been thoroughly assessed by the Panel and found satisfactory for that task. Its suitability for past requirements, however, does not make it equally suitable for the more detailed analyses of specific alignments, station design requirements and pricing strategies that will be addressed in the coming years.

### 3 Urban Modeling Approach

The Version 1.0 modeling framework has a bifurcated structure, as shown in Figure 2. CS developed original models for inter-regional travel from the 2005 RP-SP travel survey. Travel within the two major metropolitan regions – the San Francisco Bay Area and the Los Angeles Basin – is modeled using adaptations of the regional travel demand models maintained by each respective metropolitan planning organization (MPO). The person trip tables are imported directly from the MPO models, such that mode choice and preparation for trip assignment are the only parts being simulated within the intra-regional components of the Version 1.0 model. It was thought at the time that using this process would ensure consistency with the MPO forecasts, better represent the unique transit service options in each area, reduce the cost of developing socioeconomic forecasts, and enable better modeling of access and egress to HSR using the local transit systems.

Because each urban area model was developed separately and tailored to the needs of its region, the models have different constants, coefficient values, and elasticities. This added considerable complexity to the operation of the Version 1.0 modeling system. Whether the additional complexity and overhead associated with incorporating the two MPO models is worth the cost is an open question.

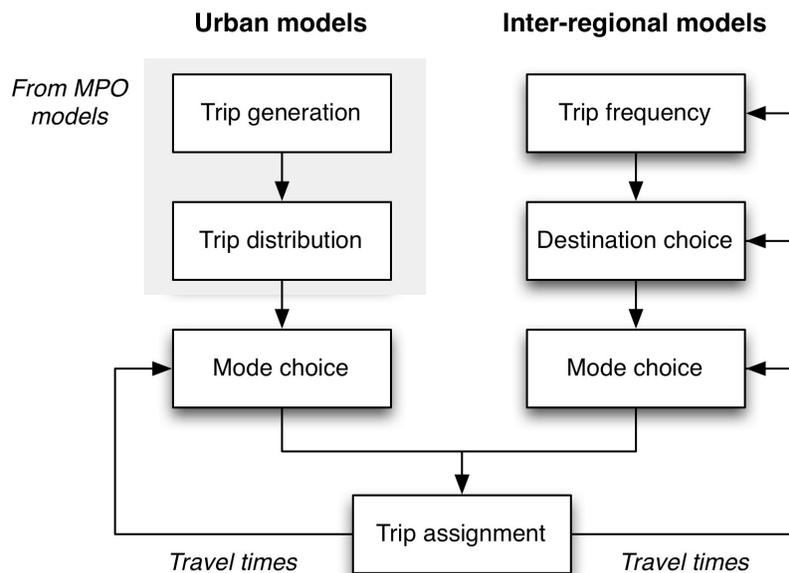


Figure 2: Version 1 modeling system structure

An alternative considered by the Panel was the development of a simpler, generic intra-regional model that could be applied in both metropolitan areas. A model of this nature would likely be more narrowly focused on HSR access and egress opportunities than all modes of transit within the metropolitan area. If successful, such a model would have a smaller data footprint, run faster, and reduce the amount of time required to check the Version 1.0 output.

CS presented an option that largely achieves the aims of this alternative while maintaining the Version 1.0 model structure and approach. It is based upon a mode choice model developed by the Santa Clara Valley Transportation Authority, which in turn is based upon a now-retired version of a model used by the San Francisco Bay Area MPO. This model will be calibrated in both MPO areas, with the only major difference being the inclusion of ferries in the lower transit nests in the Bay Area only. The two urban models will use the same nesting structure (shown in Figure 3), utility expressions, behavioral coefficients, and basic skimming procedures. Transit networks will differ by region. Like its predecessor, this model will require person trip tables by purpose, zonal data, and interzonal auto travel time (skim) matrices from the MPO models. CS intends to calibrate and validate this model to 2010 conditions.

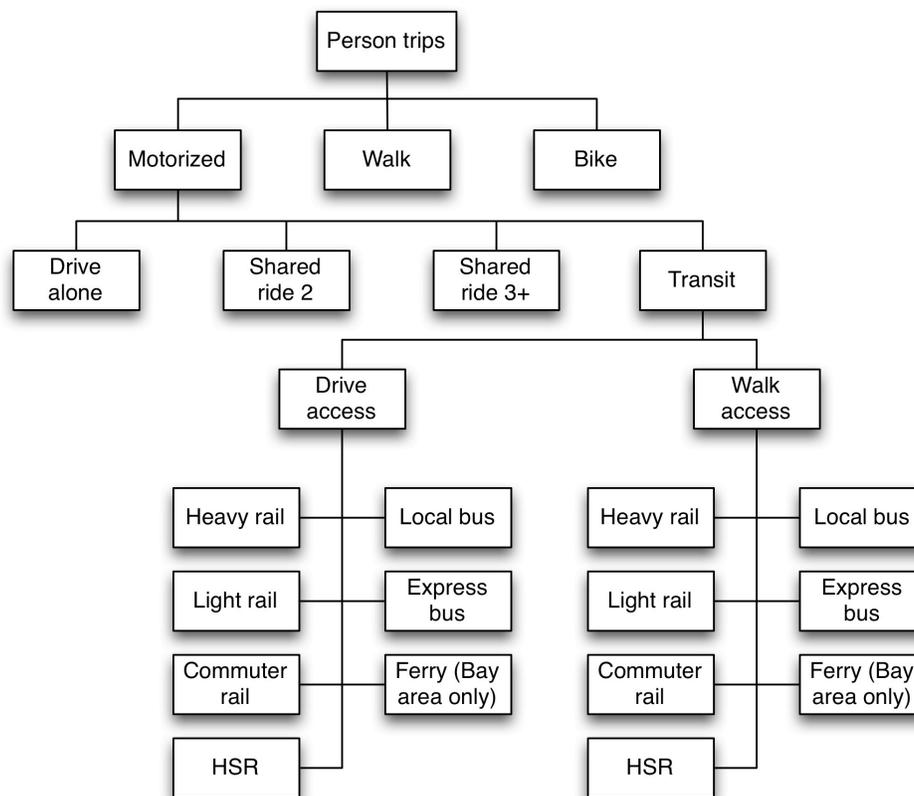


Figure 3: Urban mode choice model nesting structure

The Panel supports the proposed approach. It is viewed as an appropriate complement to the Version 1.5 work recommended by the Panel. It should be noted that each region has different transit options that will translate into differences in un-included attributes that should be accounted for. Several calibration and reasonability checks are suggested:

- Ensuring that the district-to-district level commuter rail flows match targets (important because future HSR commuters are likely to be similar to current commuter rail travelers)
- Ensuring that regional estimated and observed transit boardings by mode match reasonably well
- Reviewing the transit sub-mode bias constants for reasonableness

The Panel requests a technical memorandum from CS describing their proposed calibration and validation process at least 1 month before such is undertaken.

#### **4 Surveys**

The Version 1.0 model system was developed using data from a combined RP-SP survey conducted in 2005. A total of 2,552 usable surveys were collected from air, rail, and automobile passengers within the study area. Each survey had four stated preference experiments, resulting in 10,208 observations for model estimation. The survey methodology and results are described in Corey, Canapary & Galanis Research (2005). Aside from their age the Panel believes that the 2005 data can be improved by increasing the sample size and modifying the wording of the SP experiment to measure traveler sensitivities to changes in vehicle operating costs. The Panel strongly recommends an updated survey to overcome these and other design issues, and believes the recommended Version 1.5 will benefit substantially from this survey even in only partially completed form. Moreover, the estimation and calibration of Version 2.0 should be substantially based upon these new data, possibly combined with the 2005 RP-SP data, as noted earlier. Ideally these data will be collected in 2012, and are referred to throughout this report as the 2012 RP-SP survey data.

The 2012 RP-SP survey data will be supplemented by the on-going CHTS, which will be complete at the end of 2012. Final cleaned, checked, and expanded data and documentation are expected to become available in the spring of 2013. As noted earlier, this survey can provide the data needed to overhaul the trip frequency and destination choice models. Its larger sample size and geographic coverage will facilitate the development of robust models across a range of trip distance, trip purpose, and socioeconomic strata. Partial preliminary releases of the raw (unexpanded) survey data are available now on a monthly basis. As described above, as much of the preliminary CHTS data as are available should be used in the development of the Version 1.5 model. However, the schedule for completing this work is paramount, so delays should not be incurred in hopes of obtaining more data. Furthermore, the CHTS design did not include an SP component and, thus, did not provide information on travelers' perceptions of HSR, precluding its use in the development of the mode choice models in the Version 2.0 modeling system. Moreover, it will lack the information necessary to estimate station choice and time-of-day components, functionality that the Panel believes is essential in the Version 2.0 modeling system.

The Panel previously asked CS to present a detailed design of the 2012 RP-SP survey for review prior to proceeding with it. They presented initial thoughts about the survey on the second day of

the August 2012 meeting. A target of 4,500 completed surveys in three corridors – Bay to Valley, Valley to (LA) Basin, and Bay to Basin – has been established. This will be more narrowly focused than the CHTS upon understanding mode choice behavior relevant to the initial HSR development, especially by limiting some of the sampling to three corridors that now have relatively good conventional rail service.

The Panel agreed with recommendations from CS that focused sampling from the three corridors is superior to random sampling for our purposes. The Panel endorsed the concept of targeting similar modes, with over-sampling of rail and air passengers, as was done in the 2005 survey. Access to the Los Angeles International Airport (LAX) was not obtained during the 2005 survey; every effort should be made to get access to this important airport for the 2012 survey.

A number of other technical issues were also discussed during the meeting. Whether to include non-residents of California was debated. The Panel believes they should be included in the survey. While they are not included in the Version 1.0 model, they may form a large enough market segment for certain destinations, such as Disneyland, to affect Authority decisions. The discussion also included consideration of intercity bus service, a mode not previously surveyed. These services could compete with HSR under certain market conditions. Therefore, it would be desirable to have some survey data from intercity bus travelers to the extent it is obtained by non-dedicated survey methods. However, the Panel believes that the inclusion of non-residents and bus travelers in the new survey is not a high priority.

Both CS and the panel are concerned whether the publicity and controversy surrounding the HSR project might unduly influence survey respondents. An opponent of the project, for example, might indicate in SP experiments an unwillingness to use HSR irrespective of its characteristics compared to other options. Proponents may respond in the opposite manner. The survey would then represent, or at least be influenced by, the polarized public opinion in addition to the desired unbiased stated choice behavior. The Panel concluded that the most effective strategy is to probe respondents for strong feelings about candidate modes, and use that information as a possible explanatory variable that represents *a priori* bias in respondents' SP mode choices.

The Panel concluded that the Authority should design a survey that meets all needs described above, including, if possible, an understanding of time-of-day choice behavior. This will provide the basis for not only Version 1.5, but also the proposed Model Version 2.0 and perhaps other developments that may serve future Authority needs. The design needed for these goals is admittedly ambitious and probably expensive. Careful pilot testing of the surveys should be carried out before statewide deployment. The Panel would like the opportunity to review the survey design as soon as possible, as well as participate in the evaluation of the pilot test results and analysis of implications for final survey design.

## **5 Conclusion**

The Panel focused most of its attention during this reporting period upon options for development of the Version 1.5 and 2.0 modeling systems. The careful design and testing of a 2012 RP-SP survey is seen as central to those efforts. The Authority should expedite the survey activities as much as possible. Based upon continued schedule and resource constraints imposed by frequent forecasting deadlines, a Version 1.5 model system has been defined. The essential elements of the Version 1.5 model – that it be re-estimated based upon a fusion of 2005 and all

available preliminary 2012 data, and be rigorously validated including sensitivity testing – is a minimum set of expectations needed to be met by next summer. The Panel is convinced that such goals are within the Authority’s reach, but only by taking action upon them immediately.

## **References**

Corey, Canapary & Galanis Research (2005), “High speed rail study survey documentation”, accessed 12 July 2012 from [http://www.cahighspeedrail.ca.gov/Ridership\\_and\\_Revenue\\_Forecasting\\_Study.aspx](http://www.cahighspeedrail.ca.gov/Ridership_and_Revenue_Forecasting_Study.aspx).

Koppelman, F. & Bhat, C. (2006), “A self-instructing course in mode choice modeling: multinomial and nested logit models,” Federal Transit Administration, USDOT, accessed 23 August 2012 from [http://www.ce.utexas.edu/prof/bhat/COURSES/LM\\_Draft\\_060131Final-060630.pdf](http://www.ce.utexas.edu/prof/bhat/COURSES/LM_Draft_060131Final-060630.pdf).